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PHYTOPLANKTON COMPOSITION IN THE GARANG RIVER WATERSHED, SEMARANG, CENTRAL JAVA

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ABSTRACT

Phytoplankton are important primary producers and bioindicators of freshwater ecosystems. This study aimed to identify phytoplankton composition and abundance across three sections of the Garang River watershed, Semarang, Central Java, Indonesia. Sampling was conducted in August 2026 at three stations representing the upstream, middle, and downstream sections, with three replicates per station. Approximately 100 L of river water was filtered through a plankton net at each replicate. Phytoplankton were identified based on morphological characteristics using standard identification references. A total of 12 genera belonging to five classes were identified: Bacillariophyceae, Chlorophyceae, Zygnematophyceae, Cyanophyceae, and Euglenida, with Bacillariophyceae as the dominant class. Phytoplankton abundance was highest at Station III (1,131 individuals), followed by Station I (460 individuals) and Station II (428 individuals). The dominance of Navicula at Station III contributed to this variation, while Oscillatoria and Closterium characterized Stations I and II, respectively. These findings reveal spatial differences in phytoplankton abundance and composition and provide baseline information for freshwater ecological monitoring in the Garang River. Further investigations integrating physicochemical parameters and biological indices are needed to provide a more comprehensive assessment of the river's ecological condition.

KEYWORDS: Garang River; phytoplankton; taxonomic composition; abundance; spatial distribution; freshwater biomonitoring.

INTRODUCTION

Phytoplankton are microscopic photosynthetic organisms suspended in the water column and serve as primary producers in freshwater ecosystems. Their taxonomic composition, abundance, and diversity are influenced by environmental conditions, making them useful indicators of aquatic ecosystem status and environmental change (Borics et al., 2021; Dembowska, 2021). In rivers, these communities are shaped by physicochemical conditions, hydrological processes, and catchment characteristics, including nutrient availability, water temperature, light penetration, flow, and land use. Studies in the Yangtze River and other river systems have demonstrated that water quality, habitat characteristics, and land use influence phytoplankton composition and distribution (Gao et al., 2024; Ye et al., 2025).

Spatial variation in phytoplankton communities has been documented across river systems worldwide, including the Huaihe River (Zhang et al., 2021) and Saigon River (Nguyen et al., 2022). In Indonesia, studies have examined phytoplankton communities in the Citanduy, Bengawan Solo, and upstream Citarum rivers (Sawestri and Rais, 2021; Aida et al., 2022; Pratiwi et al., 2024), as well as the Rangkui and Babon rivers (Nurtjahya et al., 2024; Haeruddin et al., 2024). These investigations demonstrate that phytoplankton community characteristics differ among river systems depending on their environmental and hydrological settings. Consequently, site-specific assessments are necessary to document taxonomic composition and understand spatial patterns of phytoplankton communities in tropical river ecosystems.

The Garang River watershed, located in Central Java, Indonesia, comprises four sub-basins: Garang Hilir, Garang Hulu, Kreo, and Kripik (Syafrudin et al., 2023). This river system is important for regional water resources, particularly as a source of raw water for domestic supply, while also receiving inputs from residential and agricultural activities within its catchment (Utami et al., 2014). Previous investigations in the Kaligarang River documented seven phytoplankton classes, including Bacillariophyceae, Chlorophyceae, Cyanophyceae, Florideophyceae, Euglenophyceae, Charophyceae, and Synurophyceae (Utami et al., 2014), while Ujianti et al. (2019) examined phytoplankton diversity in relation to water quality. Although these studies provide baseline information, an updated assessment of phytoplankton taxonomic composition and its spatial distribution across upstream, middle, and downstream sections remains necessary, particularly considering changes in environmental conditions and anthropogenic pressures within the watershed. Therefore, this study aimed to identify phytoplankton taxa and characterize their composition and abundance across different sections of the Garang River watershed, Semarang, Central Java, Indonesia. The findings are expected to provide updated baseline information on riverine phytoplankton communities and support

ecological monitoring and watershed management.

Materials and methods

Study Area

This study was conducted in the Garang River watershed, Semarang, Central Java, Indonesia, with sampling carried out in August 2026. Three sampling stations were purposively selected to represent the upstream, middle, and downstream sections of the river (Figure 1). Station selection considered differences in surrounding land use and potential anthropogenic pressures, particularly proximity to potential pollution sources such as industrial facilities, residential areas, agricultural land, and aquaculture activities. This sampling design was intended to represent variations in environmental conditions and anthropogenic influences along the river.

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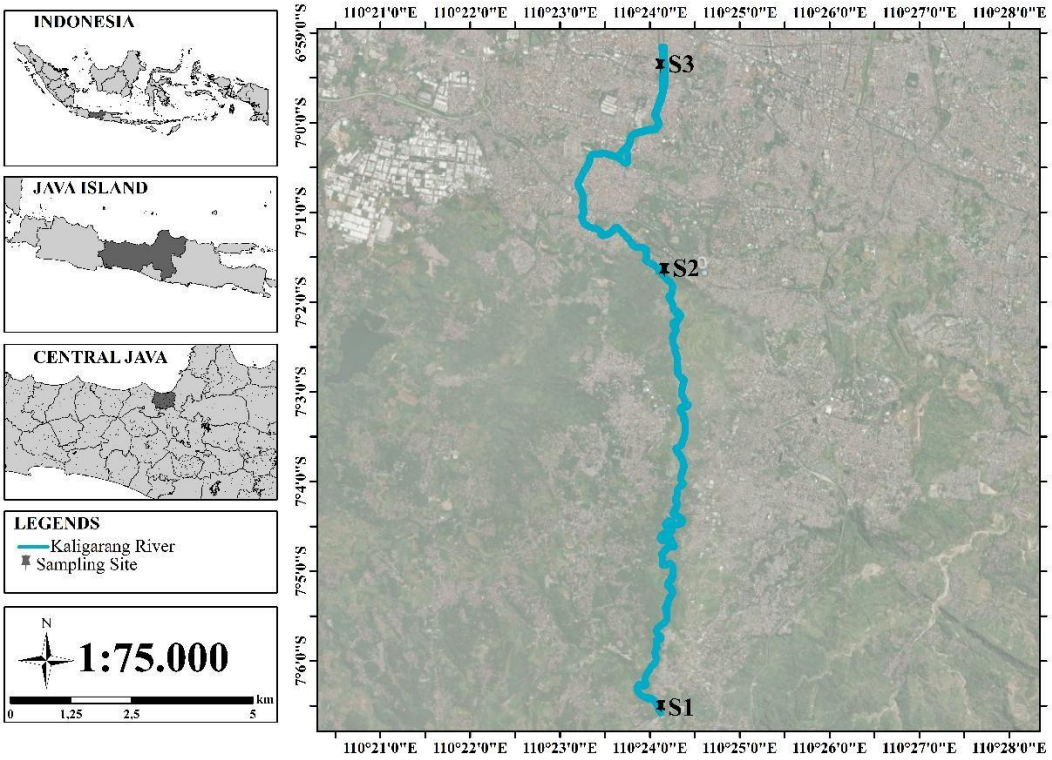


Figure 1. Study Area of The Garang River watershed, Indonesia.

Sampling Method

Phytoplankton sampling was conducted at each station with three replicates, resulting in a total of nine sampling units. At each sampling point, river water was collected using a 10-L container and filtered ten times through a plankton net to concentrate the plankton samples. Thus, approximately 100 L of river water was filtered for each replicate. This sampling procedure was adapted from Ghifari et al. (2024). The concentrated samples were collected in

100-mL sample bottles and subsequently transferred into 15-mL vials for preservation and laboratory analysis. Three drops of Lugol's iodine were added to each sample to preserve the phytoplankton. All vials were labeled according to their respective sampling stations and replicates before being transported to the laboratory.

Phytoplankton samples were examined under a microscope to determine their taxonomic composition. Identification was performed based on the morphological characteristics of the observed organisms, including cell shape, size, colony arrangement, and other distinguishing features. Taxonomic identification was carried out using standard identification references, namely Freshwater Algae of Southeast Asia by Sulastri (2018) and Easy Identification of the Most Common Freshwater Algae by Van Vuuren et al. (2006).

RESULTS AND DISCUSSION

Plankton identification at the three sampling stations in the Garang River, Semarang, identified 12 genera belonging to 5 classes of phytoplankton: Bacillariophyceae (5 genera), Cyanophyceae (1 genus), Chlorophyceae (2 genera), Zygnematophyceae (1 genus), and Euglenophyceae (1 genus). Overall, the phytoplankton assemblage was dominated by members of the class Bacillariophyceae (diatoms) at all stations. Among them, the genus Navicula exhibited the highest abundance across the entire study area, showing a pronounced upward gradient from Station I (282 individuals) and Station II (310 individuals) to a peak at Station III (1,051 individuals).

Table 1. Composition of Phytoplankton in Garang River, Semarang.

No	Classes	Family	Genera	Station		
				I	II	III
1	Bacillariophyceae	Fragilariaceae	Flagilaria	44	51	27
		Ulnariaceae	Synedra	6	1	2
		Naviculaceae	Gyrosigma	1	0	1
			Navicula	282	310	1051
		Surirellaceae	Surirella	15	15	6
		Tabellariaceae	Asterionella	1	0	1
2	Chlorophyceae	Hydrodictyaceae	Pediastrum	10	4	1
		Scenedesmaceae	Scenedesmus	3	0	0
			Tetradesmus	1	0	0
3	Euglenida	Phacaceae	Phacus	1	0	0
4	Zygnematophyceae	Closteriaceae	Closterium	5	32	17
5	Cyanophyceae	Oscillatoriaceae	Oscillatoria	91	15	25

Based on Table 1, the number of phytoplankton individuals for each genus at each sampling 98 station is presented in Figure 2. 101

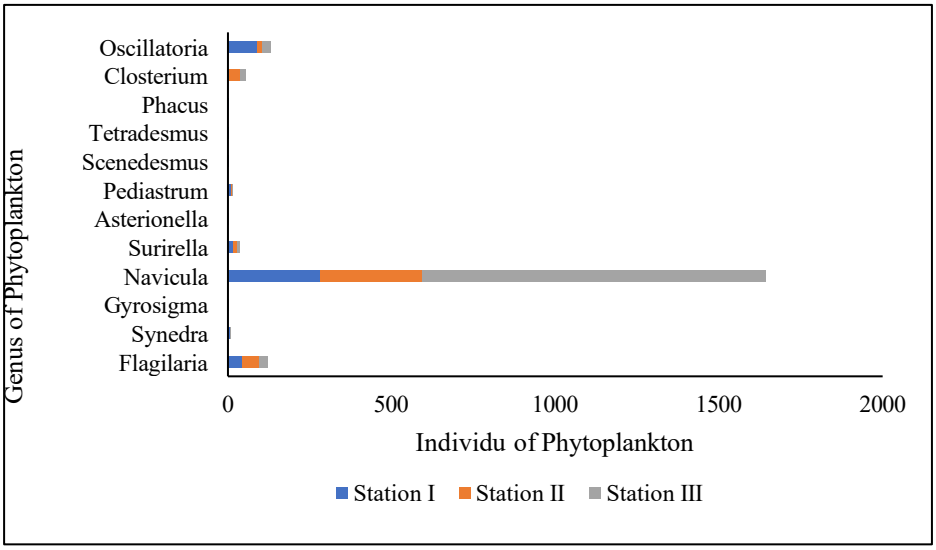


Figure 2. Number of phytoplankton in Garang River, Semarang.

A total of 12 phytoplankton genera belonging to 10 families and five classes were identified across the three sampling stations in the Garang River. The identified classes comprised Bacillariophyceae, Chlorophyceae, Euglenida, Zygnematophyceae, and Cyanophyceae. Bacillariophyceae was the most abundant group, accounting for 1,814 individuals (89.85% of the total abundance), followed by Cyanophyceae with 131 individuals (6.49%), Zygnematophyceae with 54 individuals (2.67%), Chlorophyceae with 19 individuals (0.94%), and Euglenida with only one individual (0.05%).

The predominance of Bacillariophyceae indicates that diatoms constituted the major component of the phytoplankton community in the Garang River during the sampling period. Diatoms are widely distributed in freshwater ecosystems and exhibit considerable ecological adaptability to variations in environmental conditions. Their community composition and distribution can be influenced by nutrient availability, pH, temperature, and other physicochemical characteristics of aquatic environments (Rahman et al., 2022; Wu et al., 2017). A similar pattern was reported in the nearby Babon River, Semarang, where Bacillariophyceae was also a dominant phytoplankton group (Haeruddin et al., 2024).

Among the identified genera, Navicula exhibited the highest abundance, with 1,643 individuals, representing 81.38% of the total phytoplankton abundance. This genus was recorded at all three sampling stations, with abundances of 282, 310, and 1,051 individuals at Stations I, II, and III, respectively. Its consistent occurrence across the sampling locations

suggests that Navicula was well established in the phytoplankton assemblage of the Garang River. The dominance of Navicula is consistent with findings from the Babon River, where this genus was also recorded at all sampling stations and represented the most abundant diatom genus (Rahman et al., 2022).

The high abundance of Navicula may reflect its ability to persist under varying freshwater environmental conditions. However, the dominance of this genus alone should not be interpreted as direct evidence of organic pollution or eutrophication. The ecological significance of diatom taxa depends on species-level identification and their respective environmental preferences. Therefore, further assessment of water quality should consider the composition of diatom species together with physicochemical parameters (Wang et al., 2014; Wu et al., 2017).

The representative microscopic appearances and morphological characteristics of these identified phytoplankton taxa are presented in Figure 3. 135

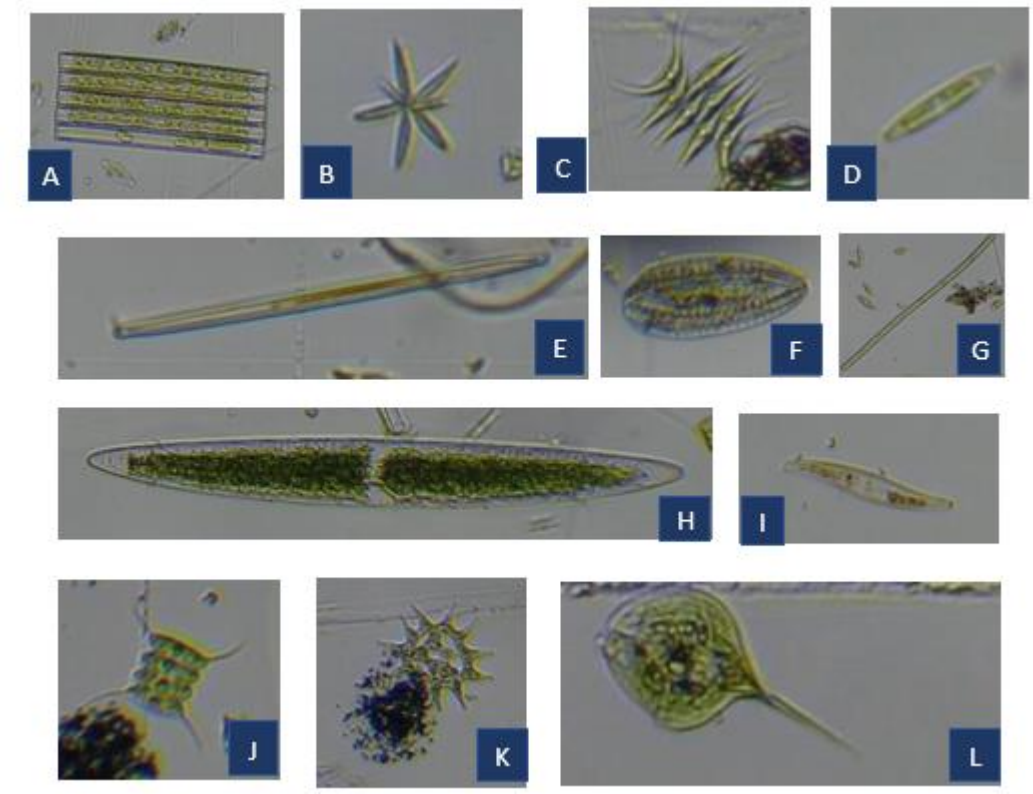


Figure 3. (a) *Flagilaria* sp. (b) *Asterionella* sp. (c) *Tetradesmus* sp. (d) *Navicula* sp. (e) *Synedra* sp. (f) *Surirella* sp. (g) *Oscillatoria* sp. (h) *Closterium* sp. (i) *Gyrosigma* sp. (j) *Scenedesmus* sp.(k) *Pediastrum* sp. (l) *Phacus* sp.

The identified genera comprised Fragilaria, Synedra, Gyrosigma, Navicula, Surirella, Asterionella, Pediastrum, Scenedesmus, Tetradesmus, Closterium, Oscillatoria, and Phacus.

The presence of these genera indicates that the phytoplankton community in the Garang River consisted of several taxonomic groups with different morphological characteristics and ecological preferences.

Bacillariophyceae was the most dominant class, represented by six genera: Fragilaria, Synedra, Gyrosigma, Navicula, Surirella, and Asterionella. Members of this class are characterized by siliceous cell walls (frustules), which exhibit diverse morphological structures, including elongated, elongated-lanceolate, and symmetrical forms. These morphological variations can be observed in the identified genera presented in Figure 2A–I. Diatoms are commonly distributed in freshwater ecosystems and are important components of aquatic primary production.

The morphological characteristics of Navicula observed in (Figure 2D) are consistent with the typical elongated, boat-shaped appearance of this genus. Members of Navicula are pennate diatoms characterized by bilateral symmetry and a longitudinal raphe, which is associated with their capacity for gliding movement. The presence of this genus across all sampling stations indicates its widespread distribution within the investigated river section. Nevertheless, genus-level identification does not provide sufficient taxonomic resolution to assign a specific pollution-tolerance category. Species-level identification and ecological index calculations would be necessary to establish a more precise interpretation of its environmental significance (Stevenson & Pan, 2010; Wu et al., 2017).

The other diatom genera also exhibited distinct morphological characteristics. Fragilaria (Figure 2A) was observed as elongated cells arranged in ribbon-like colonies, whereas Asterionella (Figure 2B) displayed a characteristic star-shaped colonial arrangement. Synedra (Figure 2E) exhibited elongated, needle-like cells, while Surirella (Figure 2F) showed an elongated oval form. Gyrosigma (Figure 2I) was characterized by an elongated, slightly curved cell shape. These morphological differences demonstrate the taxonomic variability of diatoms in the Garang River. Diatom morphology, colony formation, and cell structure are important characteristics used in freshwater algal identification (Bellinger & Sigee, 2015; Spaulding et al., 2021).

Euglenida was represented by the genus Phacus, with only one individual recorded at Station I. As shown in (Figure 2L), Phacus exhibited an oval to elongated cell body with a distinct posterior projection. Members of this genus are unicellular euglenoids characterized by a flexible cell covering and flagellar movement. Some euglenoid taxa are associated with nutrient-rich freshwater environments, particularly those influenced by organic matter availability. However, their ecological preferences are species-dependent, and the detection of

a single Phacus individual is insufficient to indicate organic pollution in the Garang River (Bellinger & Sigee, 2015).

CONCLUSION

The phytoplankton community in the Garang River consisted of 12 genera belonging to five classes, namely Bacillariophyceae, Chlorophyceae, Zygnematophyceae, Cyanophyceae, and Euglenida. Bacillariophyceae was the dominant class. The total phytoplankton abundance varied among sampling stations, with the highest abundance recorded at Station III (1,131 individuals), followed by Station I (460 individuals) and Station II (428 individuals). The pronounced dominance of Navicula at Station III contributed substantially to this spatial variation. Meanwhile, the occurrence of Oscillatoria at Station I and Closterium at Station II indicated differences in the relative composition of phytoplankton among sampling locations. Overall, these findings demonstrate spatial variations in phytoplankton abundance and community composition in the Garang River. The identified phytoplankton assemblage provides baseline information for understanding the biological characteristics of the river and highlights its potential use in freshwater biomonitoring. Further assessment integrating physicochemical parameters and biological indices are necessary to provide a more comprehensive evaluation of the river's ecological condition.

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